

## Three New Technologies Enhance Friction Stir Welding



NASA's Marshall Space Flight Center has developed three state-of-the-art technologies available for licensing to enhance friction stir welding (FSW). These new FSW technologies provide novel techniques for producing high-strength joints that are virtually free of defects. Separately or in combination, these innovations can be used by numerous commercial industries to significantly reduce tool and production costs, enhance worker safety, increase production rates, and improve weld quality.

### Benefits

- **Enables welding of more types of material than ever before:** Can be used on a wide range of alloys, including high-strength, temperature-resistant materials (such as nickel and titanium alloys), metal-matrix composites, and other materials previously considered unweldable
- **Improves weld quality:** Increased spindle revolutions per minute improves weld quality over previous conventional FSW tools and enables FSW to be incorporated into high-performance systems with higher production rates
- **Accommodates complicated welds:** Enables welding of complex curvature joints or other types of workpiece variations, increasing manufacturing possibilities
- **Lowens costs:** Eliminates the complex and expensive shoulder-angle control system, lowering costs while increasing production rates
- **Increases tool life:** Novel pin geometry and design increases strength, durability, and wear resistance, and reduces stress on tools.



## For More Information

If you would like more information about this technology, please contact:

Sammy A. Nabors  
Manager, Technology Commercialization  
and Licensing  
NASA's Marshall Space Flight Center  
256-544-5226  
sammy.nabors@nasa.gov

Karen Hiser  
Senior Consultant  
Fuentek, LLC  
919-249-0327  
nasa.msfc@fuentek.com

[www.nasasolutions.com](http://www.nasasolutions.com)

National Aeronautics and Space Administration  
**George C. Marshall Space Flight Center**  
Huntsville, AL 35812  
[www.nasa.gov/centers/marshall](http://www.nasa.gov/centers/marshall)

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## The Technology

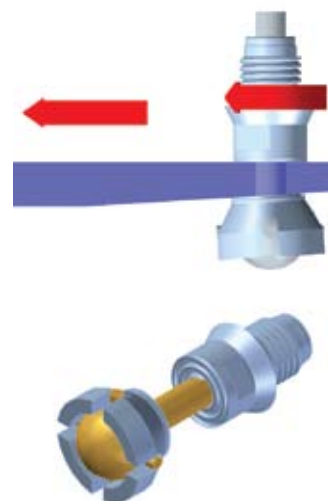
### How it works

FSW, invented by The Welding Institute in the early 1990s, is a solid-state joining process that uses friction, combined with forging pressure, to produce high-strength welds. Metals are transformed from a solid state to a plastic state through the use of a pin tool that spins at several hundred to several thousand revolutions per minute. The rapidly spinning pin tool is pushed into the material using several thousand pounds of force. This generates friction and deformation that plasticizes the material surrounding the pin tool, allowing mixing of the weld joint to occur. The high pressure created beneath the pin tool shoulder forges the material together, creating strong metallic bonds. Because no melting occurs, the welded joint is substantially stronger than a fusion weld, and virtually free of defects.

### Why it is better

NASA's state-of-the-art technologies significantly enhance the performance, efficiency, and safety of FSW.

- The gimbaled shoulder design (MFS-32115-1) allows welding of tapered or complex curvature joints and greatly reduces flash caused by the shoulder digging into the material. This eliminates the need for expensive, shoulder-angle control systems and greatly enhances worker safety.
- Novel pin tool design (MFS-31918-1) enables improved weld formation as well as higher traverse speeds and increased tool life. As a result, FSW may be applied to high-strength, temperature-resistant materials such as nickel and titanium alloys.
- The high-speed spindle (MFS-32124-1) allows greater rotation speeds than ever before (greater than 29,000 RPMs) and it can adapt to dynamically changing thrust load conditions.



*Gimballing shoulder for friction stir welding*

All three technologies, used together or individually, improve weld quality and enable greater production rates, all while improving safety by eliminating health hazards such as welding fumes, smoke, radiation, high voltage, liquid metals, arcing, and sparking.

### Patents

U.S. Patents # 7,275,675 and # 7,686,202 have been issued to NASA's Marshall Space Flight Center, covering MFS-31918-1 and MFS-32115-1 respectively. One additional patent application has also been filed.

## Licensing & Partnering Opportunities

This technology is part of NASA's technology transfer program, which seeks to transfer technology into and out of NASA to benefit the space program and U.S. industry. NASA invites companies to inquire about the licensing possibilities for these Friction Stir Welding technologies (MFS-31918-1, MFS-32115-1, MFS-32124-1) for commercial applications.

Fuentek is a contractor to NASA's technology transfer program, providing support for the access and transfer of technology.